3.3.3 Surface Water Use

Water usage in the State of Idaho is administered by the Idaho Department of Water Resources (IDWR) through a system of water rights. A water right (or "appropriation") is the right to divert the public waters of the State of Idaho and put them to beneficial use.

Surface water rights listed with IDWR are listed in **Table 3.3-9** and are shown in **Figure 3.3-4**. The project is located in State Water District 27.

TABLE 3.3-9
SURFACE WATER RIGHTS IN THE VICINITY OF NORTH RASMUSSEN RIDGE MINE EXPANSION

Water Right Number	Owner Name	Point of Diversion	Source & Tributary	Diversion Rate (cfs)	Water Uses
27-4093	Rich Sheep Co, R C (Current)	T5S R43E Sec. 32 SWSE T6S R43E Sec. 05 NWSE	Unnamed Stream tributary to Little Blackfoot River	0.02	S
27-7159	U.S. Dept. of Agriculture	T6S R43E Sec. 22 SESE	Unnamed Stream tributary to Angus Creek	0.02	S, SFS, SS
27-7161	U.S. Dept. of Agriculture	T6S R43E Sec. 27 NESE	Unnamed Stream tributary to Angus Creek	0.02	S, SFS, SS
27-7162	U.S. Dept. of Agriculture	T6S R43E Sec. 26 NWSW	Unnamed Stream tributary to Angus Creek	0.02	S, SFS, SS
27-7163	U.S. Dept. of Agriculture	T6S R43E Sec. 35 SESE	Unnamed Stream tributary to Angus Creek	0.02	S, SFS, SS
27-7208	U.S. Dept. of Agriculture	T6S R43E Sec. 14 NWNW	Unnamed Stream tributary to Sheep Creek	0.02	S, SFS, SS
27-7210	U.S. Dept. of Agriculture	T6S R43E Sec. 11 SESE	Unnamed Stream tributary to Olsen Creek	0.02	S, SFS, SS
27-7214	U.S. Dept. of Agriculture	T6S R43E Sec. 23 SWNW	Unnamed Stream tributary to Angus Creek	0.02	S, SFS, SS
27-7215	U.S. Dept. of Agriculture	T6S R43E Sec. 25 SWNW	Unnamed Stream tributary to Sheep Creek	0.02	S, SFS, SS
27-7216	U.S. Dept. of Agriculture	T6S R43E Sec. 15 SESW	Unnamed Stream tributary to Angus Creek	0.02	S, SFS, SS
27-7374	Reese, E L	T6S R43E Sec. 05 SWSE	Unnamed Stream tributary to Little Blackfoot River	0.02	G
27-11385	Vassar Revocable Trust, Donna Lue	T6S R43E Sec. 35 SWSWNW T6S R43E Sec. 35 SENESE	Angus Creek tributary to Blackfoot River	0.05	S
27-11386	Vassar Revocable Trust, Donna Lue	T6S R43E Sec. 35 NESENE T6S R43E Sec. 35 NENESE	Unnamed Stream tributary to Angus Creek	0.02	S
27-11387	Vassar Revocable Trust, Donna Lue	T6S R43E Sec. 35 NENESE T6S R43E Sec. 35 SWNWSE	Unnamed Stream tributary to Angus Creek	0.05	S
27-11414	U.S. Dept. of Agriculture; USFS	T6S R43E Sec. 27 SENW	Unnamed Stream tributary to Sinks	0.02	S
27-11415	U.S. Dept. of Agriculture; USFS	T6S R43E Sec. 27 SWNW	Unnamed Stream tributary to Sinks	0.02	S
27-11416	U.S. Dept. of Agriculture; USFS	T6S R43E Sec. 27 NWSW	Unnamed Stream tributary to Sinks	0.02	S
27-11506	U.S. Dept. of Agriculture; USFS	T6S R43E Sec. 34 SENE	Angus Creek tributary to Blackfoot River	0.02	S
27-11509	U.S. Dept. of Agriculture; USFS	T6S R43E Sec. 15 SWNE T6S R44E Sec. 30 SESE	Sheep Creek tributary to Lanes Creek	0.02	S
27-11510	U.S. Dept. of Agriculture; USFS	T6S R43E Sec. 10 SENW T6S R43E Sec. 15 SWNE	Sheep Creek tributary to Lanes Creek	0.02	S
27-11549	U.S. Dept. of Agriculture; USFS	T6S R43E Sec. 25 SWSE	Unnamed Stream tributary to Sheep Creek	0.02	S
27-11550	U.S. Dept. of Agriculture; USFS	T6S R43E Sec. 25 NESW	Unnamed Stream tributary to Sheep Creek	0.02	S
27-11743	U.S. Dept. of Agriculture; USFS	T6S R43E Sec. 25 SWSE	Unnamed Stream tributary to Sheep Creek	0.02	S

TABLE 3.3-9 (CONT.)
SURFACE WATER RIGHTS IN THE VICINITY OF NORTH RASMUSSEN RIDGE MINE EXPANSION

27-11787	U.S. Dept. of Agriculture; USFS	T6S R43E Sec. 27 SESW	Unnamed Stream tributary to Sinks	0.02	S
27-11788	U.S. Dept. of Agriculture; USFS	T6S R43E Sec. 35 SESE	Unnamed Stream tributary to Sinks	0.02	S
27-11824	U.S. Dept. of Agriculture; USFS	T6S R43E Sec. 25 SWNW	Unnamed Stream tributary to Sheep Creek	0.02	S
27-11825	U.S. Dept. of Agriculture; USFS	T6S R43E Sec. 15 SESW	Unnamed Stream tributary to Angus Creek	0.02	S

Notes:
T = township, R = range, Sec = Section, N = North, E = east, S = south, W = west, cfs = cubic feet per second
The following sections are included in the water rights database search: T6S, R43E, Sections 3,4,5,8,9,10,11,13,14,15,16,17,21,22,23,25,26,27,28
Water use categories are: S = stockwater, SS = stockwater storage, SFS = stockwater from storage, G = irrigation

3.3.4 Groundwater Flow Systems

Groundwater flow at the proposed North Rasmussen Ridge Mine has been investigated through monitoring wells, exploration borings, and published hydrogeologic reports. The locations of monitoring wells and selected exploration borings are shown in **Figure 3.3-5**. Well completion data are listed in **Table 3.3-10**.

Three distinct groundwater systems occur at Rasmussen Ridge: an upper shallow groundwater system occurs in alluvium; a shallow local to intermediate groundwater system occurs in the Rex Chert and Upper Meade Peak Members of the Phosphoria Formation; and a deeper regional groundwater flow system occurs in the underlying Wells Formation. The intermediate groundwater system is typically under unconfined conditions and occurs at depths ranging from 100 to 170 feet. The regional groundwater system occurs at greater depths ranging from 300 to 500 feet in the vicinity of the mine.

3.3.4.1 Hydrostratigraphic Units

Major hydrostratigraphic units (in descending order) in the project area consist of alluvial deposits (associated with Sheep Creek, No Name Creek, and Reese Canyon Creek), the Thaynes Formation, the Dinwoody Formation, the Phosphoria Formation, and the Wells Formation. A number of studies have described the general hydrostratigraphy of the southeastern phosphate area. In general, these sources have concluded that the Wells, Dinwoody and Thaynes formations are aquifers, while the Meade Peak Member of the Phosphoria Formation is an aquitard (Ralston et al 1980; BLM and USFS 2002).

Figure 3.3-4 Location of Surface Water Rights and Groundwater Rights

Figure 3.3-5 Groundwater Monitoring Well Locations

This page Figure 3.3-5 back.

TABLE 3.3-10 MONITORING WELL LOCATION AND COMPLETION DATA												
											10/19/2001	
WELL ID	Geologic Unit	Location				Location Description	Date Completed	Screen Depth	Total Depth	Measuring Point Elevation	Depth to Water	Groundwater Elevation
		T	R	S	1/4 1/4				(ft)	(feet amsl)	(ft)	(feet amsl)
NR-C-1	Alluvium	6S	43E	15	NENWSW	Center Area, Upper No Name Creek	8/29/2001	55-65	69.2	7026.77	68.73	<6957.57
NR-NN-1	Alluvium	6S	43E	15	NESWSE	No Name Creek	8/29/2001	25.5-35.5	38.4	6936.11	18.56	6917.55
NR-NN-2	Alluvium	6S	43E	15	SWNWSE	No Name Creek	8/30/2001	21-31	31.1	6956.71	6.45	6950.26
NR-NN-2A	Alluvium	6S	43E	15	SWNWSE	No Name Creek	9/12/2001	8-18	20.4	6955.88	5.9	6949.98
NR-NN-3	Alluvium	6S	43E	15	NENESW	No Name Creek	8/30/2001	14.5-24.5	28.6	6995.54	22.3	6973.24
NR-R-1	Alluvium	6S	43E	9	NENWSE	Reese Canyon	8/30/2001	12-22	24.8	6873.28	24.41	<6848.48
NR-R-5	Alluvium	6S	43E	9	NENWSE	Reese Canyon	9/4/2001	15.5-25.5	28.3	6842.88	28.01	<6814.58
NR-R-6	Alluvium	6S	43E	9	NENWSE	Reese Canyon	8/31/2001	13-23	25.5	6847.72	25.11	<6822.22
NR-R-7	Alluvium	6S	43E	9	SWSWNE	Reese Canyon	9/4/2001	9-19	23.0	6762.83	21.16	6741.67
NR-R-11	Alluvium	6S	43E	9	NESENW	Reese Canyon	9/23/2001	12-22	24.9	6711.58	21.9	6689.68
NR-WS-1	Alluvium	6S	43E	15	SWNENW	West Sheep Creek drainage near delineated wetlands	9/5/2001	5-12	12.0	7019.02	8.3	7010.72
NR-WS-2	Alluvium	6S	43E	15	SWNENW	West Sheep Creek drainage near delineated wetlands	9/5/2001	9-14	15.3	7027.78	13.34	7014.44
NR-WS-3	Alluvium	6S	43E	15	NENWNW	West Sheep Creek drainage near delineated wetlands	9/5/2001	13-23	23.0	7067.49	Dry	<7044.49
NR-C-4	Rex Chert	6S	43E	15	NWNESW	Center Area	9/12/2001	140-160	164.5	7011.82	158.58	6853.24
NR-R-2	Rex Chert	6S	43E	9	NENWSE	Reese Canyon	9/15/2001	97-117	119.3	6849.61	116.06	6733.55
NR-R-12	Rex Chert	6S	43E	9	SWSWNE	Reese Canyon, near NR-00-89	10/2/2001	91-121	124.0	6768.08	102.67	6665.41
NR-C-3	Upper Meade Peak	6S	43E	15	NWNESW	Center Area	9/11/2001	175-195	197.5	7011.97	170.38	6841.59
NR-R-3	Upper Meade Peak	6S	43E	9	NENWSE	Reese Canyon	9/14/2001	136-156	158.9	6849.08	158.44	<6690.18
NR-C-5	Lower Meade Peak	6S	43E	15	NWNESW	Center Area	9/27/2001	194-214	217.0	7018.76	Dry	<6801.76
NR-R-8	Lower Meade Peak	6S	43E	9	NENWSE	Reese Canyon near NR-00-73	9/22/2001	117-137	139.4	6869.63	Dry	<6730.23
NR-C-2	Wells Formation	6S	43E	15	NWNESW	Center Area	9/25/2001	216.6-236.6	239.7	7019.33	Dry	<6779.63
NR-C-6	Wells Formation	6S	43E	15	NWNESW	Center Area	9/29/2001	167-299	301.7	7022.53	Dry	<6720.83
NR-C-7	Wells Formation	6S	43E	15	NENENW	Center Area	10/4/2001	478.5-498.5	501.0	7028.16	Dry	<6527.16
NR-R-4	Wells Formation	6S	43E	9	NENWSE	Reese Canyon	9/21/2001	165-185	187.5	6869.81	Dry	<6682.31
NR-R-9	Wells Formation	6S	43E	9	SWSWNE	Reese Canyon near NR-00-87	9/23/2001	180-200	203.9	6825.08	Dry	<6621.18
NR-R-10	Wells Formation	6S	43E	9	NENWSE	Reese Canyon	9/19/2001	315-335	340.0	6850.68	Dry	<6510.68

Note: amsl = above mean sea level

Alluvium exists in areas of Reese Canyon Creek, No Name Creek, and the West Fork of Sheep Creek. The alluvium encountered while monitoring wells were drilled in Reese Canyon consisted of a gravelly silt and clay to gravel ranging from 5 to 25 feet thick. Alluvium in the No Name Creek area consisted of primarily gravelly silt with some clayey silt and silty sand, with thicknesses ranging from 24 to 32 feet. In the area of the West Fork of Sheep Creek, the alluvium is described as silt and clay with some gravelly intervals. The alluvium in this area ranged from

11 to 24 feet thick (Maxim 2002b). The alluvium described above exists unconformably on the underlying bedrock.

The Thaynes Formation occurs outside the proposed pit area, but within the hydrologic study area. The Thaynes Formation overlies the Dinwoody Formation and is approximately 2,200 to 2,800 feet thick. It can be divided into five members that include, from top to bottom, the Portneuf Limestone, Nodular Siltstone, Black Shale, Platy Siltstone, and Black Limestone (Ralston et al 1980). Hydrologic data for the Thaynes Formation have not been developed for the project area and are not reported in any documents reviewed to date. Hydrologic studies by Robinette (1977) and Mohammad (1976) concluded that the Thaynes Formation represents an intermediate flow system in the Idaho phosphate region and can be classified as an aquifer throughout its thickness.

The Dinwoody Formation overlies the Phosphoria Formation and is approximately 900 feet thick. It is composed of interbedded limestone and siltstone with discontinuous shaley zones in the upper portion of the formation, and calcareous shale and siltstone with thin limestone beds in the lower portion of the formation. Hydrologic studies by Robinette (1977), Edwards (1977), and Mohammad (1976) concluded that the Dinwoody Formation represents an intermediate flow system in the Idaho phosphate region, with the upper section acting as an aquifer and the lower section acting as an aquitard.

The Phosphoria Formation in the area of the proposed North Rasmussen Ridge Mine ranges from approximately 250 to 450 feet and consists of the Rex Chert member and the Meade Peak Member.

The Rex Chert is the uppermost member of the Phosphoria Formation and occurs below the Dinwoody Formation. In the project area, the Rex Chert is 100 to 200 feet thick and is composed of dark gray to reddish brown cherty mudstone and limestone. The Rex Chert is described in on-site boring NR-R-3 as gray-black claystone, dark gray siltstone, gray-black mudstone with dark gray to brown gray chert, gray black to brown mudstone with some chert, and gray-black hard mudstone with minor chert, and the total thickness was 120 feet (Maxim 2002a). Hydrologic studies by Robinette (1977), Edwards (1977), and Mohammad (1976) concluded that the Rex Chert constitutes an intermediate flow system in the Idaho phosphate region and classified the unit as an aquifer.

The Meade Peak Member of the Phosphoria Formation is generally characterized as relatively impermeable and consists of phosphatic shale and limestone. The Meade Peak member is 140 feet thick in the area and contains two separate ore zones (the upper and lower ore) separated by 60 to 100 feet of shales. The phosphate deposit generally strikes north 44 degrees west and is normally bedded to the east with dips ranging from 33 to 78 degrees. The upper ore of the Meade Peak Member was characterized by the on-site borings as consisting of reddish brown to black shale, siltstone, and chert, with olitic grain texture present in the ore bearing siltstone. The center waste shales of the Meade Peak are described as gray to black shale and mudstone and gray to black hard mudstone interbedded with soft clay (Maxim 2002a).

The Grandeur Member of the Park City Formation is present below the Phosphoria Formation in the general area of the mine. Rocks of the Grandeur Member are thick to massively bedded gray dolomite that is occasionally sandy or argillaceous and may be recrystallized in its upper portion. Regionally, the unit is about 100 feet thick (Ralston et al 1980) and has been mapped as part of the Wells Formation (Mansfield 1927).

The Wells Formation is considered a regional aquifer that is responsible for interbasin flow along bedding (Ralston et al 1980). The upper member of the Wells Formation typically ranges from 1,000 to 1,400 feet thick and is composed of buff-colored sandy limestone, gray to reddish brown sandstone and interbedded gray limestone and dolomite (Ralston et al 1980). The lower member ranges from 500 to 950 feet thick and consists of medium bedded gray cherty limestone with some interbedded sandstone (Ralston et al 1980). In the area of the mine, the combined thickness of the Wells Formation (including the Grandeur Member of the Park City Formation) is mapped as about 2,400 feet (Mansfield 1927). The Wells Formation as characterized by the on-site borings is gray to light gray limestone interbedded with sandstone. The sandstone is described as yellow-brown to orange to gray to brown, calcareous, and fine to very fine-grained (Maxim 2002a). None of the monitoring wells on site are completed in the saturated portion of the Wells Formation. However, Dust Control Well #2 and exploration drill holes (NR00-53, NR00-77, NR00-81, NR00-99, NR00-102, and NR00-109) have provided information about the hydraulic characteristics of the Wells Formation.

3.3.4.2 Hydraulic Characteristics

The hydraulic characteristics of the alluvial and bedrock aquifers were investigated by pumping tests and slug tests in on-site monitoring wells. Additional data were compiled from wells outside the immediate project area. These tests provide estimates of hydraulic conductivity, transmissivity, and storativity. Hydraulic conductivity and transmissivity are measures of the ease water flows through an aquifer; higher values indicate that more water can be transmitted through the aquifer. Storativity is the volume of water an aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in head.

The alluvial aquifers on site were characterized by slug-in and slug-out tests. These tests consist of the removal of a known volume of water (slug-out) or the introduction of a known volume of water (slug-in) and subsequent monitoring of the water levels in the well over time. Three wells were tested in the No Name Creek alluvium, two wells in the Reese Canyon Creek alluvium, and one well in the West Sheep Creek alluvium. The results of the on-site testing are shown in **Table 3.3-11**. The results from alluvial wells in the region were also compiled and combined with the site-specific data (**Table 3.3-12**). The geometric average hydraulic conductivity for the alluvium, based on all available data, is 0.31 feet per day (ft/day), with a median (middle value) of 0.13 ft/day.

Hydrologic data were not collected for the Dinwoody Formation in the project area. However, slug tests in the Little Long Valley indicate that values for hydraulic conductivity range from 83 to 620 ft/day (Ralston et al 1980).

TABLE 3.3-11
SUMMARY OF ON-SITE AQUIFER TESTING RESULTS

Slug Tests

Well Tested	Type of Test	Formation Screened	Hydraulic (ft/day)	Conductivity (cm/sec)
NR-NN-1	Slug In	Alluvium	0.15	5.3E-05
NR-NN-1	Slug Out	Alluvium	0.12	4.2E-05
NR-NN-2	Slug In	Alluvium	2.12	7.5E-04
NR-NN-2	Slug Out	Alluvium	3.71	1.3E-03
NR-NN-2A	Slug In	Alluvium	0.02	7.1E-06
NR-NN-2A	Slug Out	Alluvium	0.01	3.5E-06
NR-R-7	Slug In	Alluvium	0.02	7.1E-06
NR-WS-1	Slug Out	Alluvium	0.04	1.4E-05
NR-R-11	Baildown-Recovery	Alluvium	1.28	4.5E-04
NR-C-4	Slug In	Rex Chert	0.10	3.5E-05
NR-R-2	Slug In	Rex Chert	0.16	5.6E-05
NR-C-3	Slug In	Upper Meade Peak	0.08	2.8E-05
NR-R-12 Pumping Test				
Observation Well	Analytical Method	Formation Tested	Hydraulic (ft/day)	Conductivity (cm/sec)
NR-R-12	Cooper & Jacob (1946)	Rex Chert	7.26	2.6E-03
NR-R-12	Theis Unconfined (1935)	Rex Chert	5.37	1.9E-03
NR-R-12	Theis Recovery (1946)	Rex Chert	14.9	5.3E-03
NR-00-89	Cooper & Jacob (1946)	Rex Chert	8.49	3.0E-03
NR-00-89	Theis Unconfined (1935)	Rex Chert	6.19	2.2E-03
NR-00-89	Theis Recovery (1946)	Rex Chert	7.23	2.6E-03

Notes: ft/day = feet per day
cm/sec = centimeters per second

The Rex Chert Member has been described as a potential aquifer of moderate hydraulic conductivity. Both slug and pump tests were conducted on the Rex Chert in the project area (**Table 3.3-11**) and additional data were compiled from outside the project area, including Dry Valley and Diamond Creek (**Table 3.3-12**). The site-specific data varied from a low value of 0.1 ft/day from a slug test on well NR-C-4 to a high of 14.9 ft/day from a pumping test on well NR-R-12 at Rasmussen Ridge. Values from the Rasmussen Ridge data were typically higher for pump tests than for slug tests and higher than the values from surrounding sites. A statistical analysis of available data indicates that the geometric mean hydraulic conductivity of the Rex Chert is 1.5 ft/day and the mean storage value is 0.014. Fracturing may increase hydraulic conductivity locally, with reported values in fracture Rex Chert ranging from 28 to 75 ft/day. Observed storage values in fractured Rex Chert vary from 0.0003 to 0.001.

TABLE 3.3-12
SUMMARY OF ALL AVAILABLE AQUIFER HYDRAULIC CHARACTERISTICS

Unit	Aquifer Property	Min.	Max.	Mean	Geometric Mean	Median	Std. Dev.	Number of tests
Alluvium	K (ft/day)	0.014	55.0	8.47	0.314	0.134	20.54	7
Alluvium	T (ft2/day)	3200	3200	3200	3200	3200	N/A	1
Alluvium	S (/ft)	N/A	N/A	N/A	N/A	N/A	N/A	0
Dinwoody	K (ft/day)	N/A	N/A	N/A	N/A	N/A	N/A	0
Dinwoody	T (ft^2/day)	83	620	351.5	226.8	379.7	351.5	2
Dinwoody	S (/ft)	N/A	N/A	N/A	N/A	N/A	N/A	0
Rex Chert (Unfractured)	K (ft/day)	0.1	8.3	2.8	1.52	2.3	2.6	13
Rex Chert (Unfractured)	T (ft^2/day)	153.7	1200	514.7	394.0	423.4	380.4	8
Rex Chert (Unfractured)	S (/ft)	0.007	0.028	0.014	0.0111	0.007	0.012	3
Rex Chert (N.Ras. Ridge)	K (ft/day)	0.1	8.34	3.96	0.99	3.70	4.45	4
Rex Chert (N.Ras. Ridge)	T (ft^2/day)	153.7	177.0	165.4	165.0	165.4	16.5	2
Rex Chert (N.Ras. Ridge)	S (/ft)	0.028	0.028	0.028	0.028	0.028	N/A	1
Rex Chert (Fractured)	K (ft/day)	28	75	51.5	45.8	51.5	33.23402	2
Rex Chert (Fractured)	T (ft^2/day)	2300	12000	7150	5253.6	7150	6858.936	2
Rex Chert (Fractured)	S (/ft)	0.0003	0.001	0.00065	0.0005477	0.00065	0.000495	2
Meade Peak (Unfractured)	K (ft/day)	0.03	11.5	2.39	0.80	1.30	3.15	17
Meade Peak (Unfractured)	T (ft^2/day)	6.0	300	79	36	23	105	11
Meade Peak (Unfractured)	S (/ft)	0.001	0.002	0.002	0.002	0.002	0.001	2
Meade Peak (Fractured)	K (ft/day)	25	25	25	25	25	N/A	1
Meade Peak (Fractured)	T (ft^2/day)	2000	2000	2000	2000	2000	N/A	1
Meade Peak (Fractured)	S (/ft)	0.001	0.001	0.001	0.001	0.001	N/A	1
Wells Formation	K (ft/day)	0.08	9.94	1.82	0.65	0.64	3.33	8
Wells Formation	T (ft^2/day)	4	3600	523	85	70	1245	8
Wells Formation	S (/ft)	0.0016	0.0078	0.0047	0.0035	0.0047	0.0044	2

Notes:
k = hydraulic conductivity
T = transmissivity
S = storage coefficient
ft/day = feet per day
ft^2/day = square feet per day

The Grandeur Member of the Park City Formation is generally mapped as part of the Wells Formation. Local hydrologic data are not available for the Grandeur Member; however, a pumping test indicated a hydraulic conductivity less than 108 ft/day in the area of the Gay Mine (Geraghty and Miller 1990).

No hydrologic data for the Wells Formation are available from the project area. Data are available, however, from pumping tests in wells at the Smoky Canyon and Dry Valley Mines and from well records in the general area. A hydraulic conductivity of 0.56 ft/day for the Wells Formation was derived from a pumping test in well GW6D at the Dry Valley Mine. Transmissivities ranging from 33 to 689 ft^2/day were also calculated for four pumping tests in the Wells Formation at the mine during 1990 (Raviv and Patricio 1990). Semi-confined storage values for the 1990 pumping tests were calculated to range from 0.00276 to 0.00352. Based on a screened interval of 50 feet for the pumped wells, hydraulic conductivities for the 1990 Dry Valley pumping tests are calculated to vary from 0.67 to 13.8 ft/day.

Data from a pumping test in the Culinary Well at Smoky Canyon indicated a transmissivity of 3,600 square feet per day (ft^2/day) for a screened interval of 610 feet (Ralston et al 1980). Assuming that transmissivity equals hydraulic conductivity multiplied by the length of the screened interval, a hydraulic conductivity of 0.79 ft/day for the Wells Formation can be calculated.

A specific capacity analysis for hydraulic conductivity was also performed for other wells in the general area that are completed in the Wells Formation. Hydraulic conductivity was calculated from specific capacity using a Jacob Straight Line analysis as described in Driscoll (1995) and Freeze and Cherry (1979). The Wooley Valley Wash Plant # 1 well, 0.34 ft/day for the Donna Vasser Well, and 9.94 ft/day for the Gail Gentry well were identified as completed in the Wells Formation and were used for the analysis. Assuming a storage value of 0.001, hydraulic conductivities were calculated at 0.19 ft/day for the Wooley Valley Wash Plant # 1 well, Donna Vasser well, and Gail Gentry well.

Statistical analysis of data for the Wells Formation provides a mean hydraulic conductivity of 1.82 ft/day and a mean storage value of 0.0047. Fracturing may increase hydraulic conductivity locally. Hydrologic studies by Robinette (1977), Edwards (1977), and Mohammad (1976) concluded that the Wells Formation is an aquifer and may be part of a regional groundwater flow system.

3.3.4.3 Groundwater Flow Directions, Recharge, and Discharge

Groundwater generally flows from areas of recharge to areas of discharge. This flow can occur in local-, intermediate-, or regional-scale systems, depending on topography, geologic structure, and continuity of formations.

The structure and topography of Rasmussen Ridge play an important role in controlling the direction of groundwater flow. Rasmussen Ridge is formed as a result of the Snowdrift anticline, a northwest-southeast trending structure (**Figure 3.1-1**). At the north end of Rasmussen Ridge, the anticline is part of the upthrown block of a horst and graben structure. The Enoch Valley Fault lies along and on the south side of the length of Rasmussen Ridge. Rasmussen Ridge is the upthrown side of the fault; the Georgetown syncline is on the downthrown side of the fault (**Figure 3.1-1**). Two minor faults exist on the north side of Rasmussen Ridge, one in the area of No Name Creek and the other near the top of Reese Canyon. A map depicting the geologic features in the area and cross-sections through the northern and central portions of Rasmussen Ridge (Mansfield 1927) are shown in **Figure 3.1-1**.

Groundwater in the alluvium forms local flow systems that generally follow topography and flow downgradient parallel to drainages (**Figure 3.3-6**). Groundwater in the alluvium is often perched above the local and intermediate bedrock flow systems and feeds local seeps and springs (Maxim 2002c, Whetstone 2002). Water levels in the alluvial monitoring wells vary seasonally, as shown in **Table 3.3-13**.

Groundwater in the Dinwoody Formation and Rex Chert typically form local to intermediate flow systems that are isolated from the regional flow system by shales of the Meade Peak Member of the Phosphoria Formation (**Figure 3.3-7**). Based on water levels in wells installed by Maxim (2002d), a differential of more than 225 feet exists between the local and intermediate flow system in the Rex Chert and the regional flow system in the Wells Formation in the vicinity of Reese Canyon. Water levels in the Rex Chert vary seasonally, with as much as 60 feet of seasonal change in water level measured in Reese Canyon well NR-R-2 (**Figure 3.3-8**). Groundwater in the Rex Chert originates in recharge areas along the axis of Rasmussen Ridge and other topographic high points where the Rex Chert outcrops. Data from the three monitoring wells and one water supply well installed in the Rex Chert indicate that groundwater follows topography and flows downstrike westward in the valley of No Name Creek and eastward in Reese Canyon under steep hydraulic gradients (0.68 ft/ft). Bedding in the Rex Chert dips 35 to 75 degrees toward the northeast in the project area, and data are not available to indicate a downdip component of flow.

The Meade Peak Member of the Phosphoria Formation acts as a low-permeability barrier to groundwater flow, resulting in several hundred feet of difference in water level elevation between the local/intermediate flow systems in the Dinwoody and Rex Chert and the regional flow system in the Wells Formation (**Figure 3.3-9**). Two monitoring wells completed in the Upper Meade Peak Member (NR-C-3 and NR-R-3) show significant seasonal variation in water levels)172.8 and 158.5, respectively, Maxim 2002d).

Groundwater in the Wells Formation is part of the regional groundwater flow system. Recharge to the Wells Formation occurs along anticlinal axes (such as Rasmussen Ridge) or other areas where the Wells Formation is elevated relative to the discharge area. Maxim (2002d) compiled data on regional water levels for the Wells Formation aquifer (**Figure 3.3-10**), which indicate that groundwater in the regional bedrock aquifer flows from southeast to northwest, generally toward the discharge area at the northern Blackfoot Reservoir with a gradient of 0.0059 ft/ft.